Rainwater tank study of new homes

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UWSRA Science & Stakeholder Engagement Forum #4
The objectives

- Determine the quantity of water savings from rainwater tanks
- Identify opportunities to improve water savings
- Understand how pumping energy use can be improved
Household characteristics

- All owner occupied single dwellings from throughout Sydney
- Occupied 2004 to 2008, most from 2007
- Majority of lot sizes between 400 and 800 m²
- 60% were 4 bedroom homes
- Average occupancy rate 3.55 (survey based)
Metering layout

- Potable Water
- Rain Water
- Optional Connection

- Float valve (optional)
- Switching device (optional)
- Outdoor tap(s)
- Toilet
- Washing machine (cold)
- Laundry (cold)
- Other household uses (shower, hot water etc)

Graphs:
- Water or energy use, L or Wh
- Water use, L

- Top-up (Meter B)
- Rainwater (Meter A - Meter B)
- Power (Meter C)
- Mains (Meter D)
Water demand and savings

Rainwater tanks reduced household mains water demand by 21%

Key stats in kL/household/year
- Total household demand: 197
- Demand for end uses connected to rainwater tank: 59
- Water saved: 38
What influenced water savings

- Rainfall 20% lower than average
- Large roof area connected: 210 m² average
- Large tank sizes: 4,200L average
- High proportion of toilet and washing machine connections

<table>
<thead>
<tr>
<th>Connection type</th>
<th>Monitoring sample</th>
<th>Survey sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Garden</td>
<td>100%</td>
<td>52</td>
</tr>
<tr>
<td>Toilet</td>
<td>92%</td>
<td>48</td>
</tr>
<tr>
<td>Washing machine</td>
<td>65%</td>
<td>34</td>
</tr>
</tbody>
</table>
Type of water use
Where in the house was the rainwater used?

Primarily small demand, low flow rate events
How to improve water savings
Monitoring and site inspection outcomes

In general, the rainwater tanks performed well

Average water savings could increase by ensuring:
- all houses maximise their roof area connection
- the top-up level is set appropriately
- end uses are connected, especially washing machines
How to measure performance
Modelling rainwater tank use with real demands and local rainfall

![Graphs showing demand, rainfall, and modelled volume within tank over time.]

- **Demand, L**: The graph on the left shows the demand plotted over time from June 2009 to April 2010, with peaks indicating periods of high demand.
- **Rainfall, mm**: The right graph illustrates rainfall over the same period, with spikes representing rainfall events.
- **Modelled volume within tank, L**: The bottom graph depicts the modelled volume within the tank over time, showing how it changes in response to demand and rainfall.
Linking water demand to energy use
One minute interval data provides the key

[Graph showing water use and energy use from 05:45 to 06:45]

- Blue line: Rainwater
- Green line: Power

Water use or energy use, L or Wh

0 2 4 6 8 10

05:45 05:55 06:05 06:15 06:25 06:35 06:45

Stand-by energy use
Active pumping energy use
Energy demand and intensity
How much energy did the pumps use?

- Energy use: 78 kWh/year
- Energy intensity: 1.48 kWh/kL (median), 2.03 kWh/kL (mean)
- Energy intensity while pumping 1.42 kWh/kL
How does this compare
With water supplied from other sources?

- Dams to central Sydney: less than 0.3 kWh per kL
- Dams to urban fringes: 0.5 to 1.5 kWh per kL
- Rainwater tanks: 1.5 kWh per kL
- Recycled water: 1 to 2 kWh per kL
- Desalination: 3 to 4 kWh per kL

Energy intensity kWh/kL:
- 2.75 to 3
- 2.5 to 2.75
- 2.25 to 2.5
- 2 to 2.25
- 1.75 to 2
- 1.5 to 1.75
- 1.25 to 1.5
- 1 to 1.25
- 0.75 to 1
- 0.5 to 0.75
- 0.25 to 0.5
- 0.01 to 0.25
Flow rate impact on energy use
Flow frequency and amount, L in a minute

Maximum flow rate had an average of 16.5 L/min
Correctly sizing pumps using energy intensity curves

Specifications (assumed 65% efficiency)

Active energy intensity, kWh/kL

Flow, L in a minute

Submersible pumps
Above ground pumps
Importance of pump selection
Instantaneous energy intensity for the median flow rate

Median flow rate of 6 L in a minute
End use energy intensity

Median energy intensity of end uses, kWh/kL

- Toilets – half flush: 2.08
- Toilets – full flush: 1.84
- Washing machines: 1.29
- Large use events: 1.2

But...the difference in energy intensity is lower for well performing pumps.
Outcomes

Water

- Rainwater tanks were shown to successfully save water when installed properly.
- There are easy steps to improve the sustainability of urban tanks.
- Tanks and pumps need to operate well or customers may not use the tank.

Energy

- Selecting pumps that operate efficiently at flow rates between 5 and 10 L/min is the most critical factor for reducing energy demand.
- Pressure tanks have been shown to be an effective way to achieve this.
Questions